Future opportunities for Earthquake Risk Assessment in the Caribbean

First International Workshop "Caribbean Waves

9-10 December 2008
GUADELOUPE
French West Indies

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Global Earthquake Model (GEM)

- A private/public partnership that is created with goal to reduce the scourge of earthquakes
- Support from Global Science Forum of OECD and Munich RE
- GEM aims to create a common framework for reducing earthquake risk by:

  – Building on state-of-the-art advances in seismic knowledge
  – Improve international cooperation in research and practice
  – Continuing hazard assessment programs as it harmonizes methodologies and extend them to risk assessment programs

- Global budget will be 35 million Euros. 25 million raised already
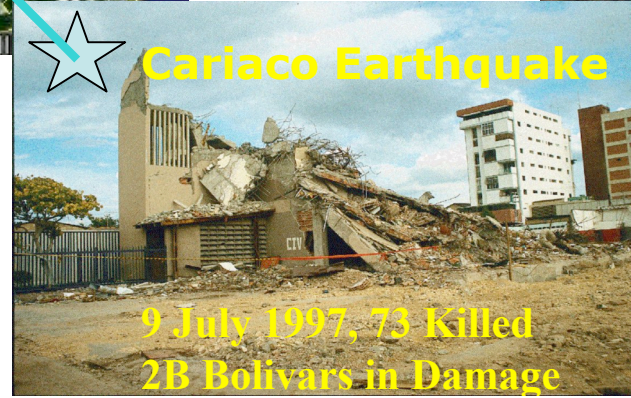
Significant Recent Disasters Near T'nT

Volcanic Eruption in Montserrat 1995 - ?

19 Killed, Costs Multi-$B

**Les Saintes Earthquake
21 Nov 2004**

$19 M Damage in D'ca

Caraballeda Floods
Jan 19, 2000, 6000 Killed
$2 B in Damage

Cariaco Earthquake

9 July 1997, 73 Killed
2B Bolivars in Damage

Hurricane Ivan

Killed 39 in G'da

90% of homes damaged
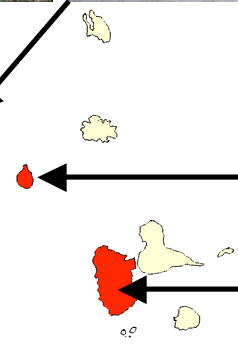
The Bottom, Saba

Mt. Liamuiga, St. Kitts

Nevis Peak, Nevis

Soufriere Hills, Montserrat

The Quill, St. Eustatius

Volcanoes of the Eastern Caribbean
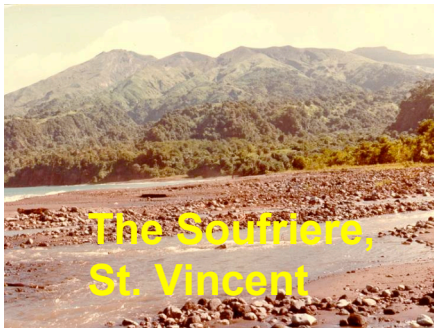
La Soufriere, Guadeloupe

Morne Aux Diables, Dominica

Sulphur Springs, St Lucia

Montagne Pelee, Martinique

The Soufriere, St. Vincent
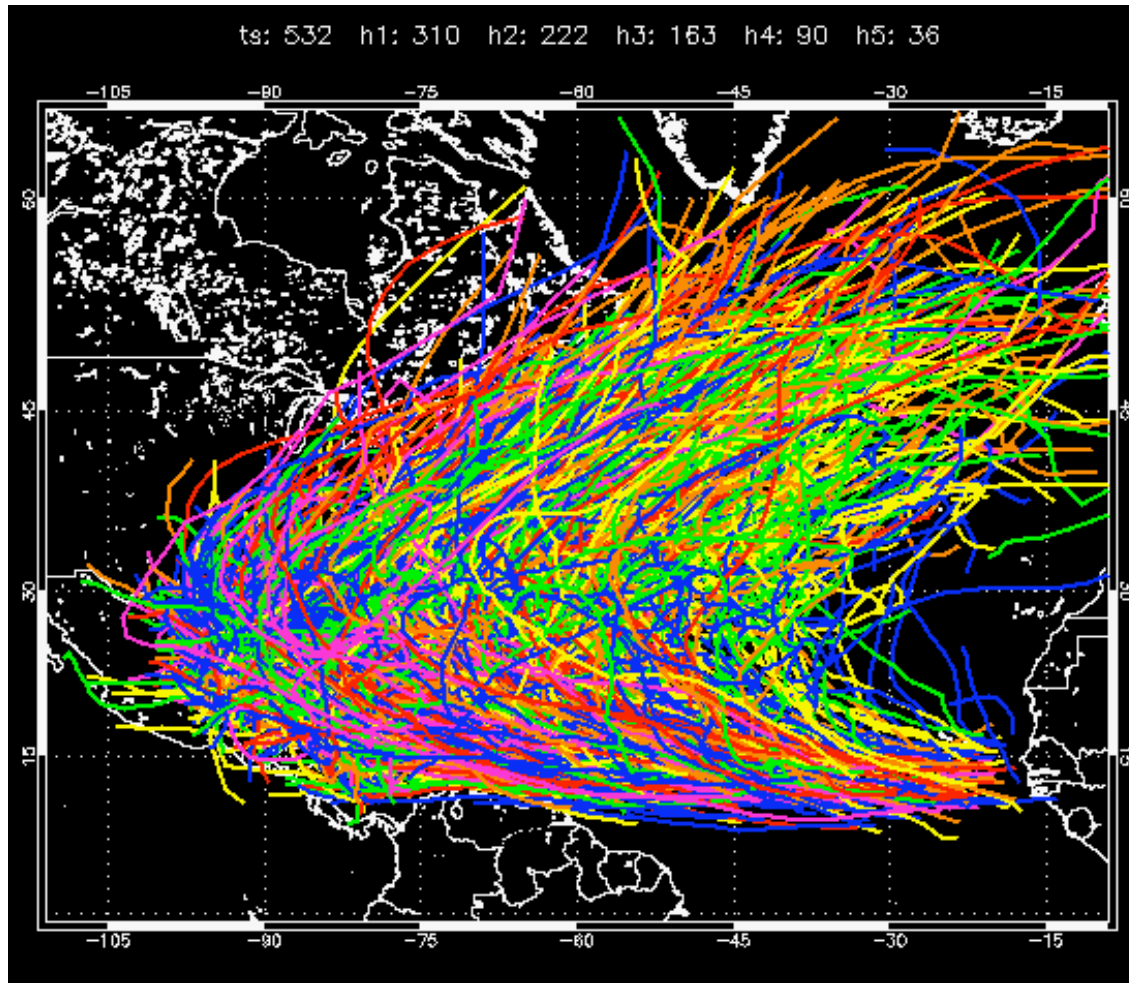
Kick 'em Jenny

Mt St. Catherine, Grenada

Paths of Atlantic Storms (1851-2000)

ts: 532   h1: 310   h2: 222   h3: 163   h4: 90   h5: 36

Trop. Depression < 65km/h

Trop. Storm   65 – 118 km/h

Hurricane   >118 km/h

| ts | h1 | h2 | h3 | h4 | h5 |

EARTHQUAKE

FAULT RUPTURE

VIBRATION

FOUNDATION SETTLEMENT

FOUNDATION FAILURE

LURCHING

LIQUEFACTION

LANDSLIDE

COMPACTION

SEICHE
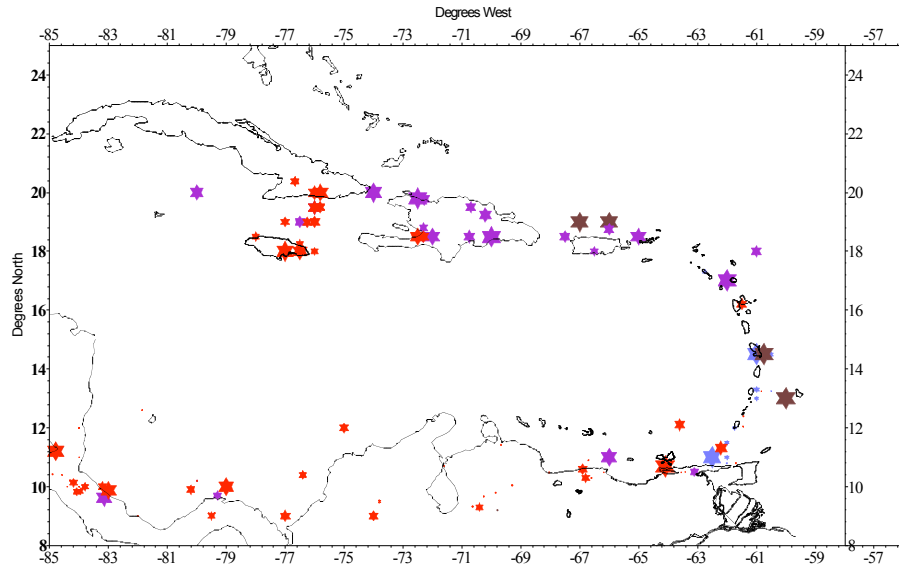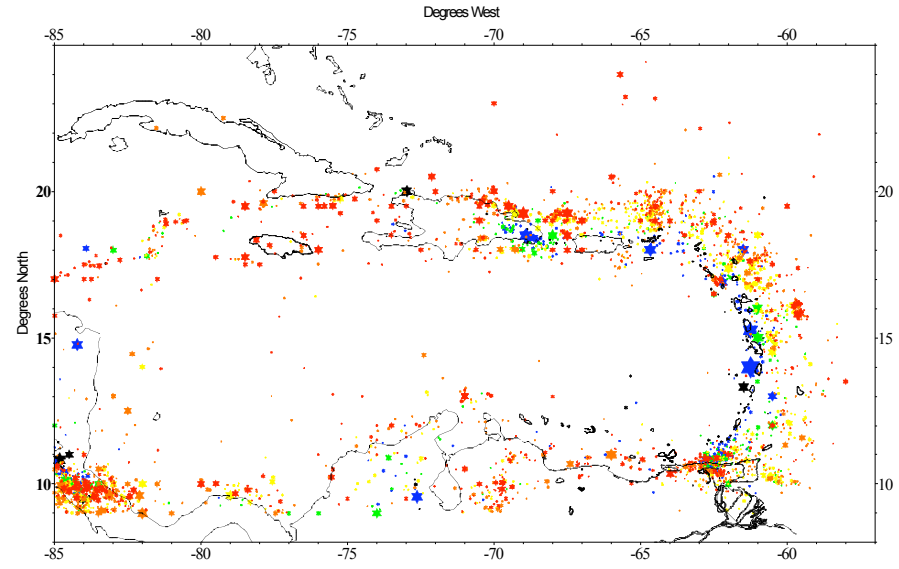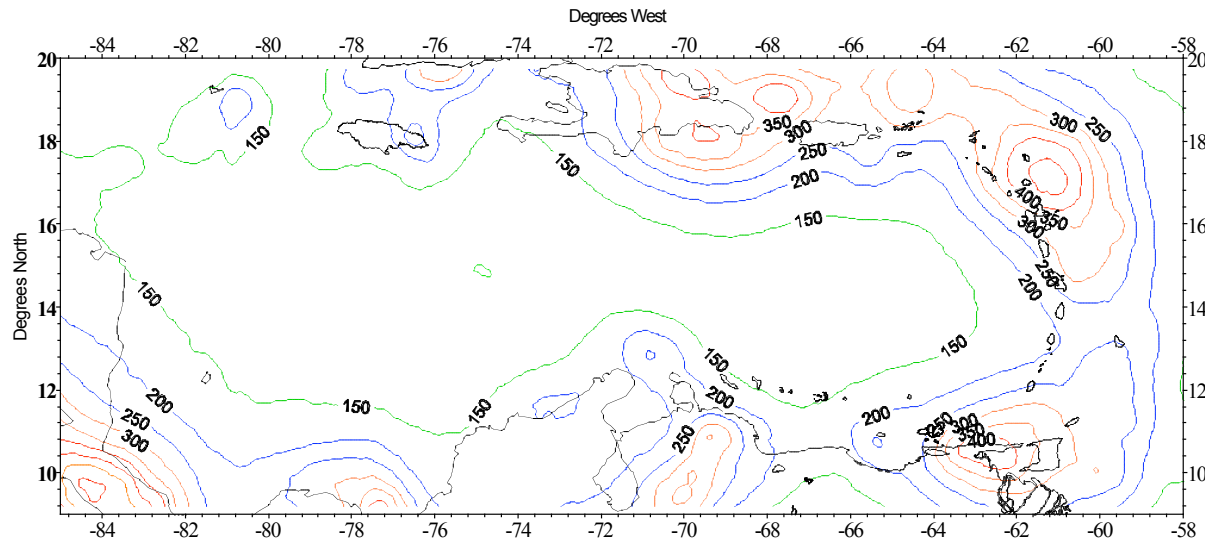
TSUNAMI
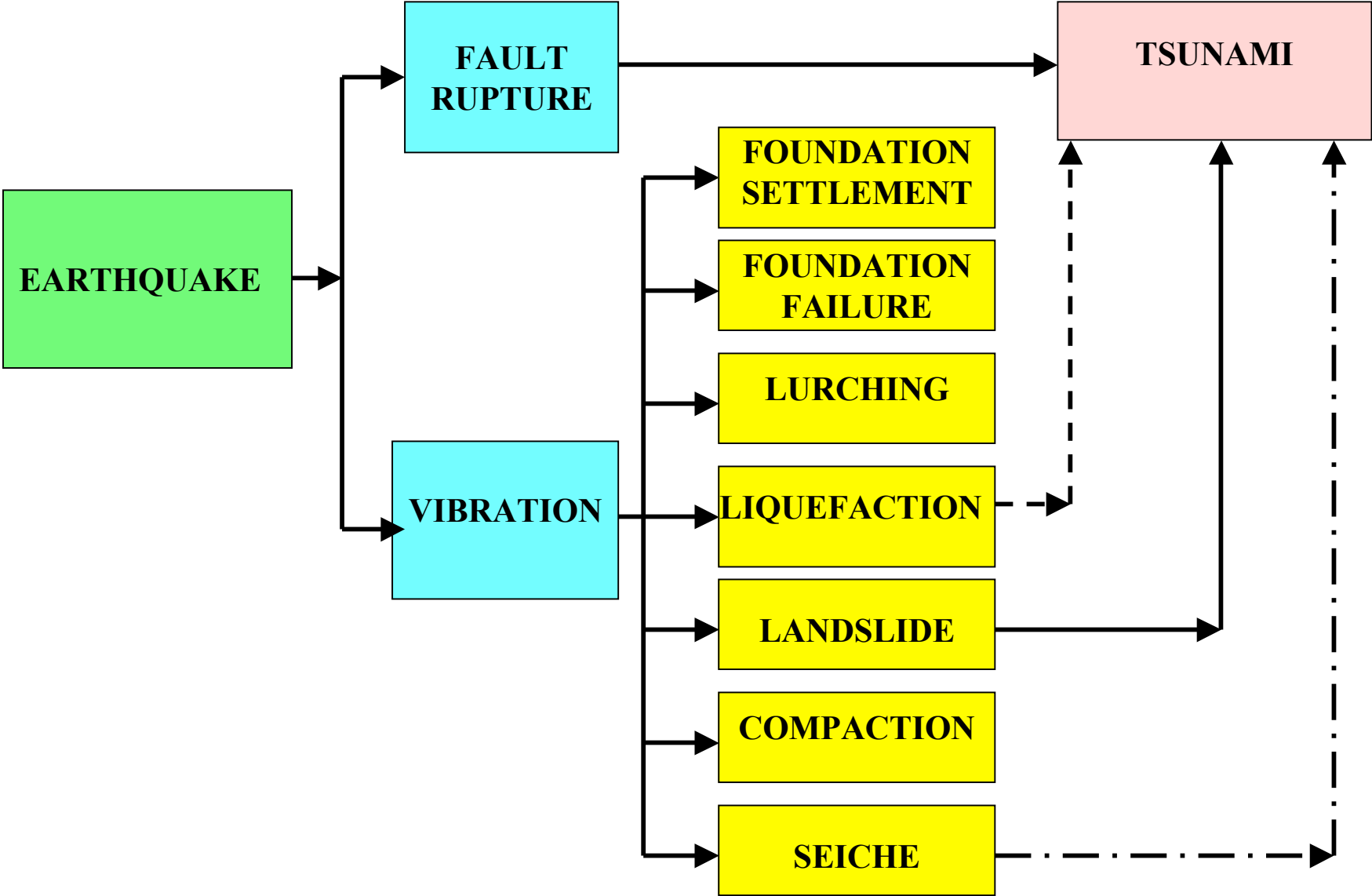
Historical Seismicity of the Caribbean

Seismicity of the Caribbean 1900-93 Mw > 4

Ground acceleration with 10% probability of exceedance in any 50-year period (gal)
Contour interval 50 gal

Intensity Distribution 1530 - 1900

Region	Intensity				
	X	IX	VIII	VII	VI
Cuba	-	2	10	5	4
Jamaica	1	-	1	1	11
Haiti	2	2	2	7	2
Dom. Rep	-	3	3	-	4
Puerto Rico	-	-	2	4	2
Virgin Is.	-	-	2	-	2
Lesser Ant., North	1	-	3	3	2
Lesser Ant., Central	-	2	1	2	3
Lesser Ant., South	-	-	-	4	5
Barbados	-	-	-	-	4
Trinidad	-	-	2	2	4

Frequency of Expected Earthquakes

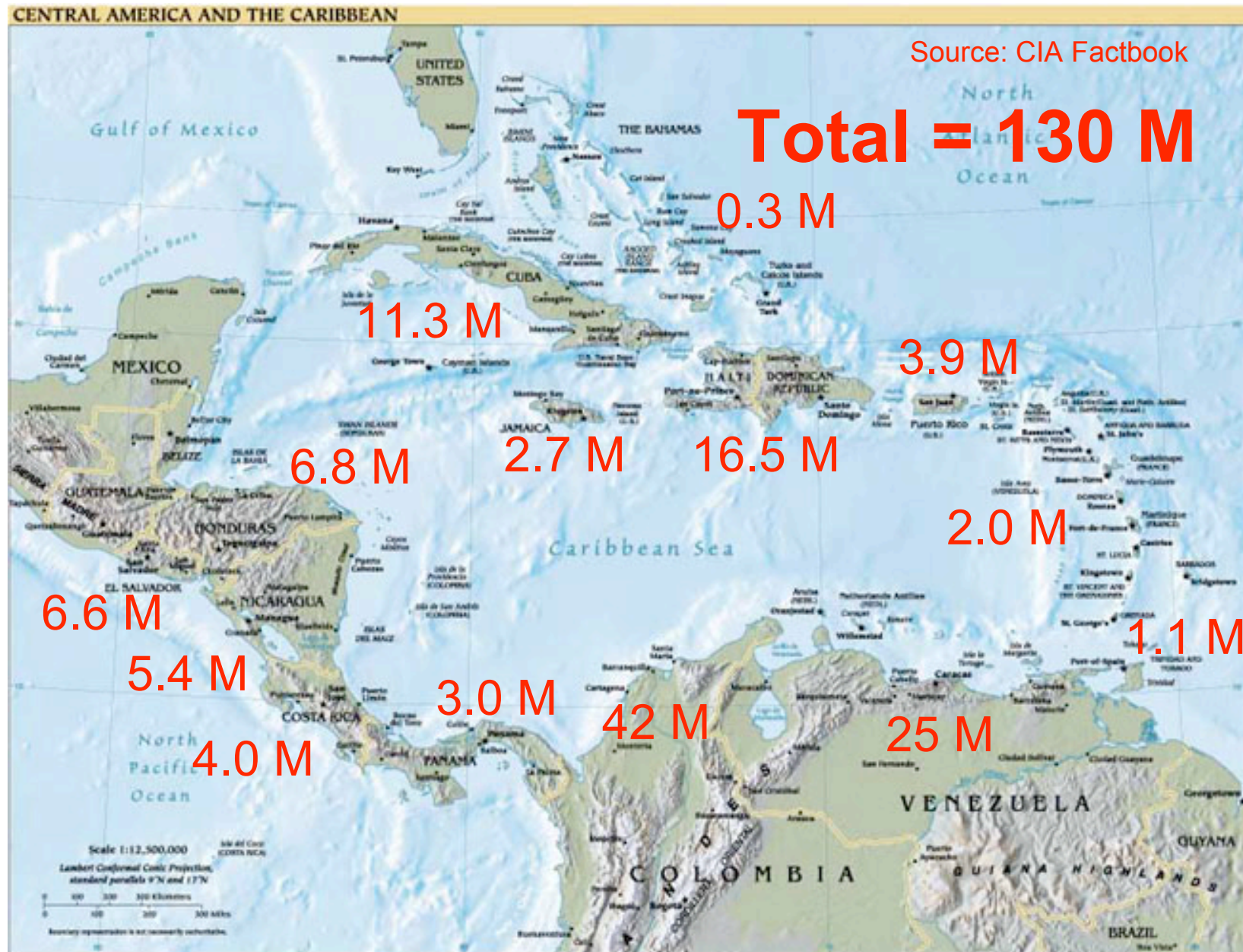| Earthquake Magnitude	Caribbean	Atlantic and Caribbean
Felt Event	85/year	N/A
Mw >= 5.0	50/year	N/A
Mw >= 6.5	1/3 years	1/year
Mw >= 7.0	1/5 years (?)	1/3 years (?)
Mw >= 7.5	1/8 years (??)	1/6 years (??)
Mw >= 8.0	1/50 years (???)	1/15 years (???)

Sources of information: PRSN and USGS

circum-Caribbean seismicity (defines plate)
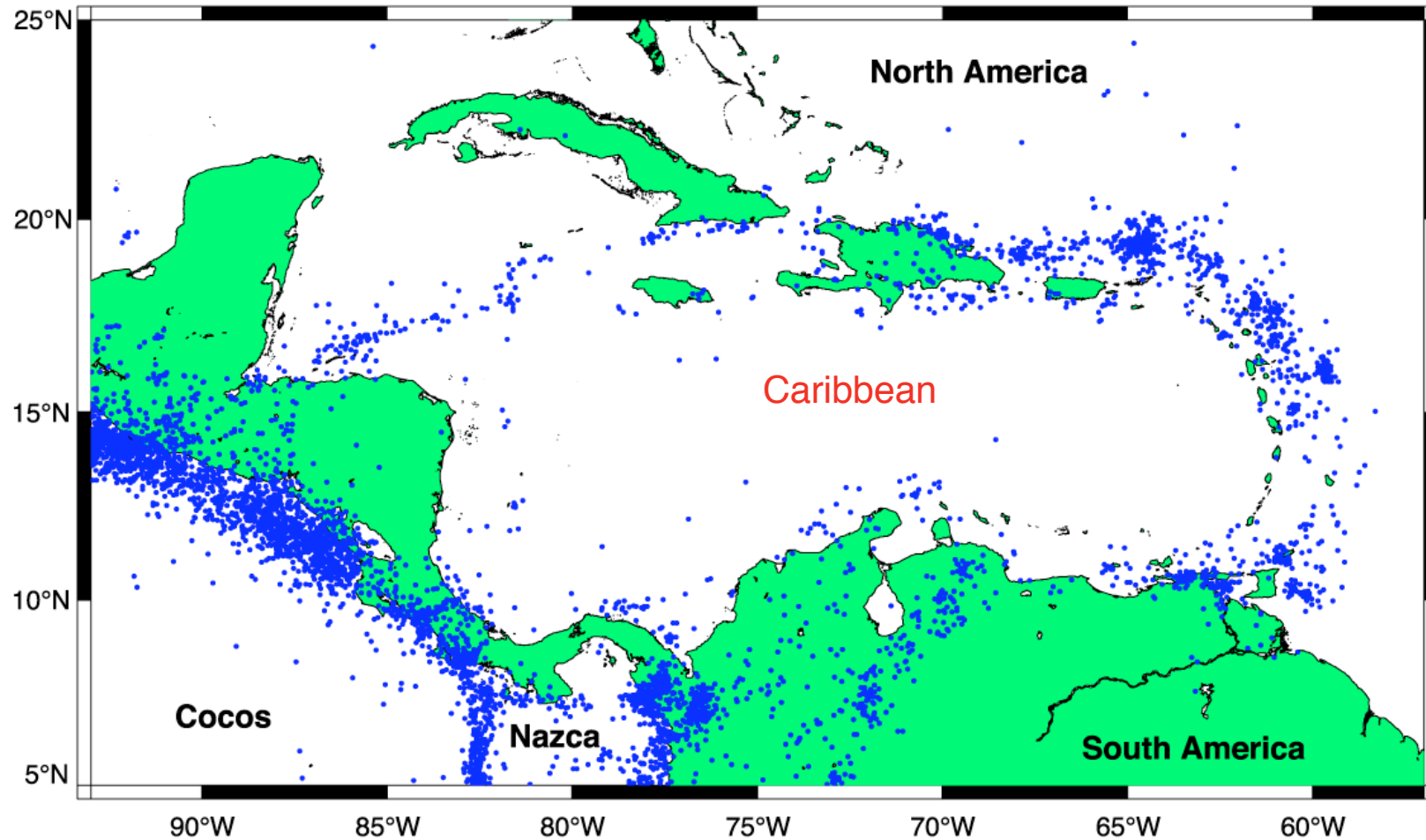
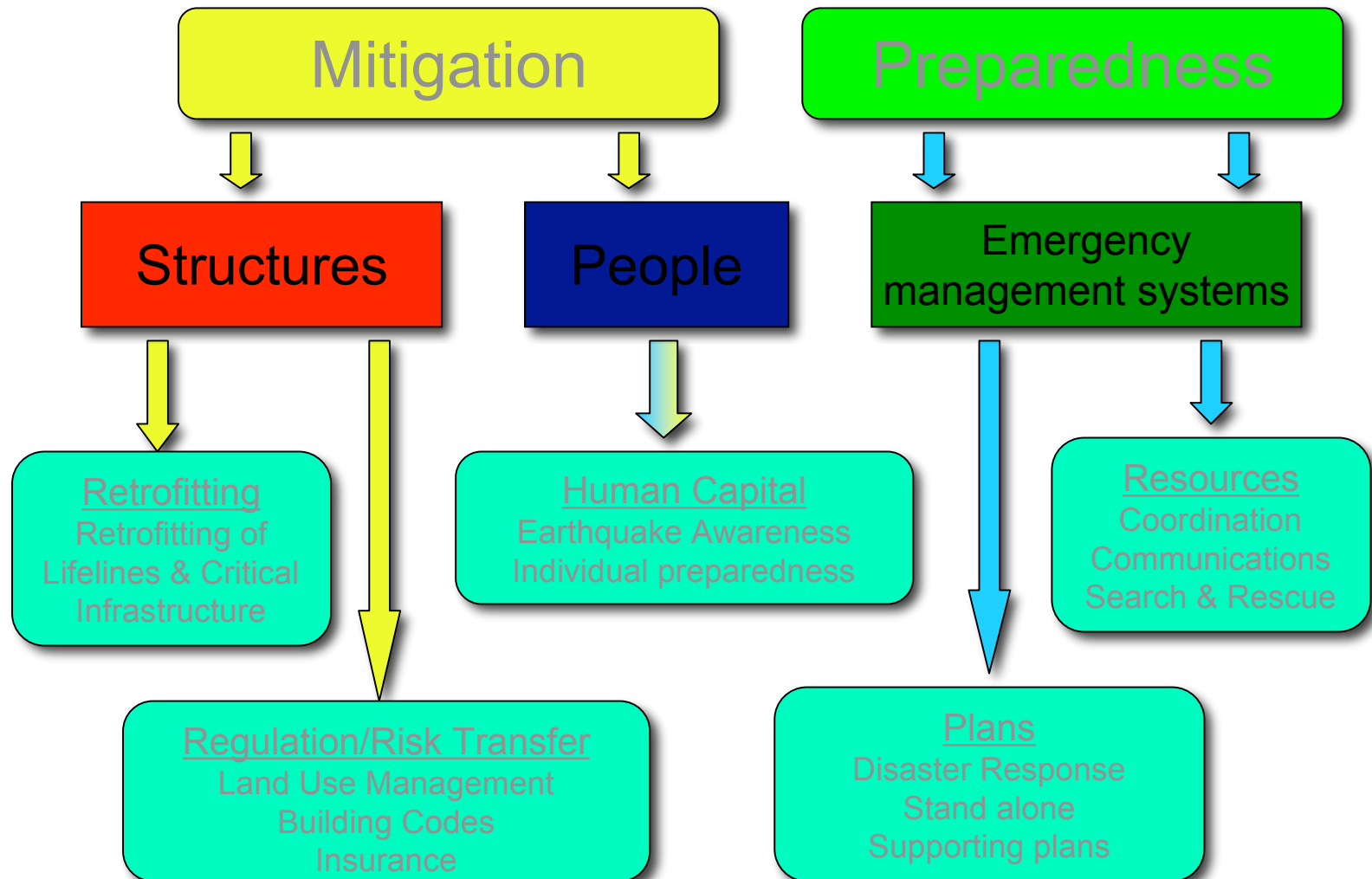

epicenters < 30 km depth

Population at Risk for Natural Hazards

CENTRAL AMERICA AND THE CARIBBEAN

Source: CIA Factbook

Total = 130 M

0.3 M

11.3 M

3.9 M

6.8 M   2.7 M   16.5 M

2.0 M

6.6 M

5.4 M

3.0 M

42 M

25 M

1.1 M

4.0 M

Earthquake Risk Reduction Program

Mitigation

Preparedness

Structures

People

Emergency management systems

Retrofitting
Retrofitting of Lifelines & Critical Infrastructure

Human Capital
Earthquake Awareness
Individual preparedness

Resources
Coordination
Communications
Search & Rescue

Regulation/Risk Transfer
Land Use Management
Building Codes
Insurance

Plans
Disaster Response
Stand alone
Supporting plans
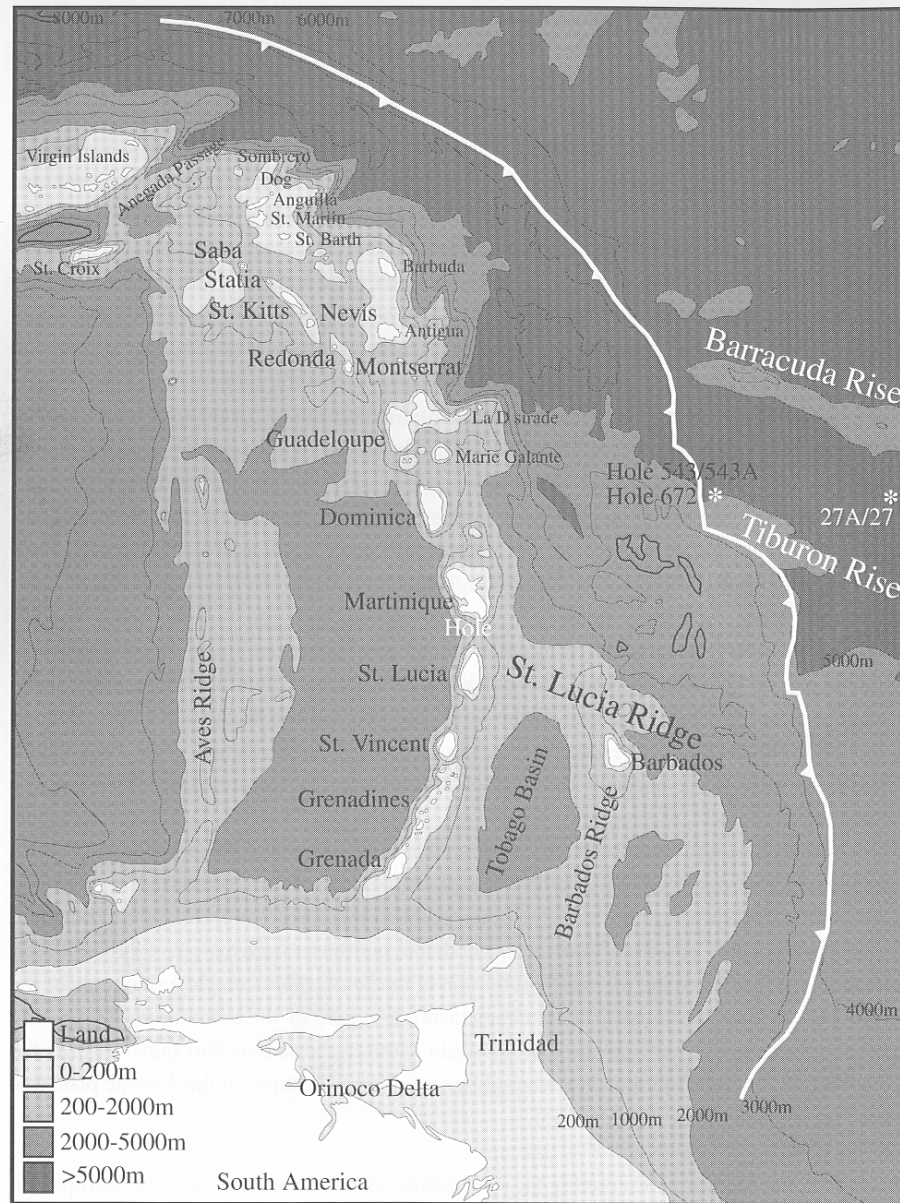
Motivation for embracing GEM

Figure 2.5: A detailed map of the Lesser Antilles island arc and its surrounding bathymetry. Notice the clear expression of the Barbados Ridge accretionary prism and its extent up to about Martinique. (Redrawn after: Maury, et al., 1990)

To improve knowledge of seismic source zones

- Necessary input for tsunami modeling

- Necessity to compute seismic hazard potential provision for the IBC 2000 or later. This is the building code used by regional Engineers

EC is Ocean-Ocean Convergent Zone. Most of land surface submerged Tectonic features are inaccessible

Modern instrumentation and state-of-the-art research tools/methods are highly desirable because of the capability to make accurate remote measurements of eq. source and crustal parameters

Real-time Broadband Seismic Stations in the Caribbean And Adjacent Regions
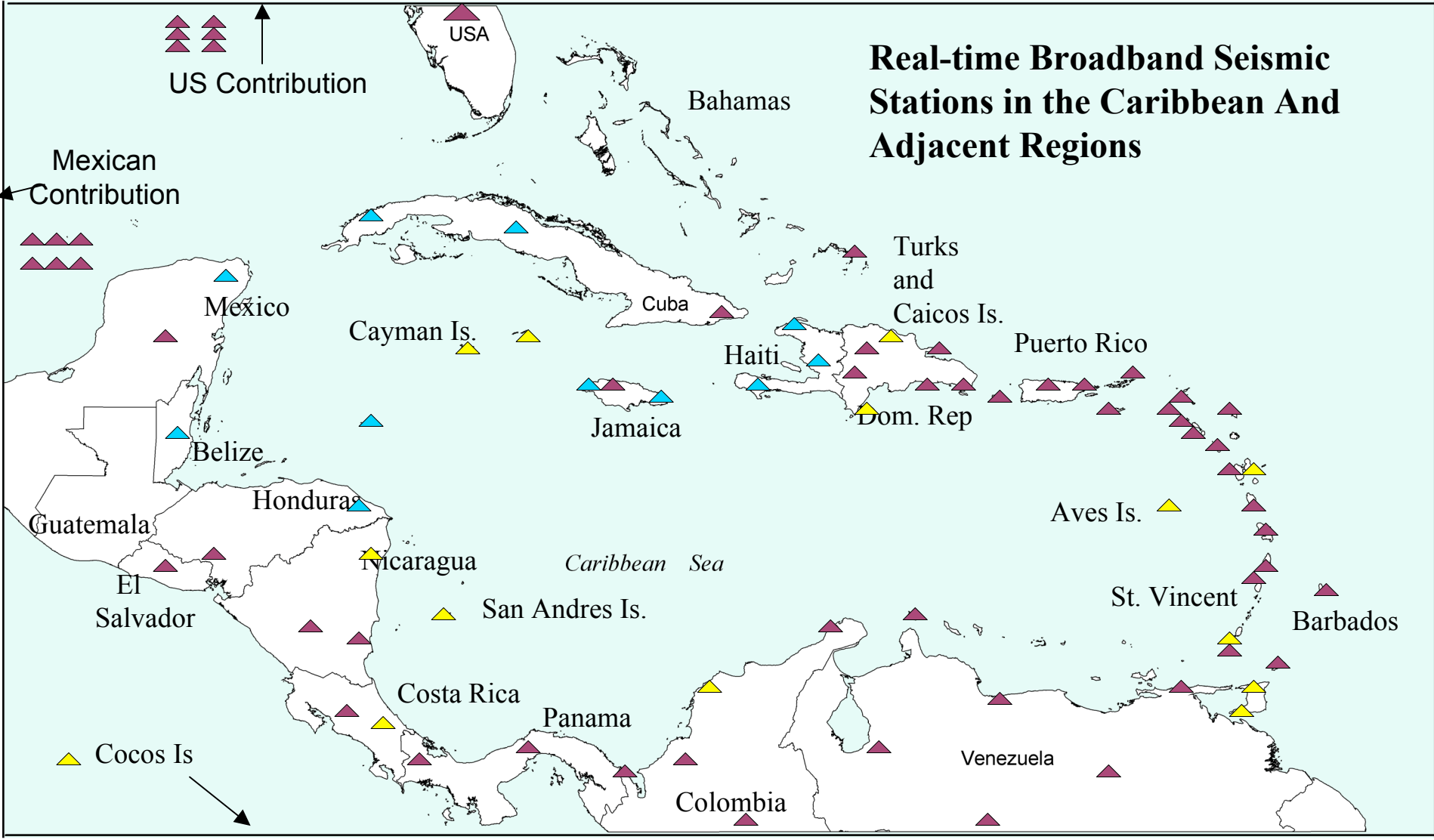
CORS Network for Geodynamic Studies

External CORS

Community CORS
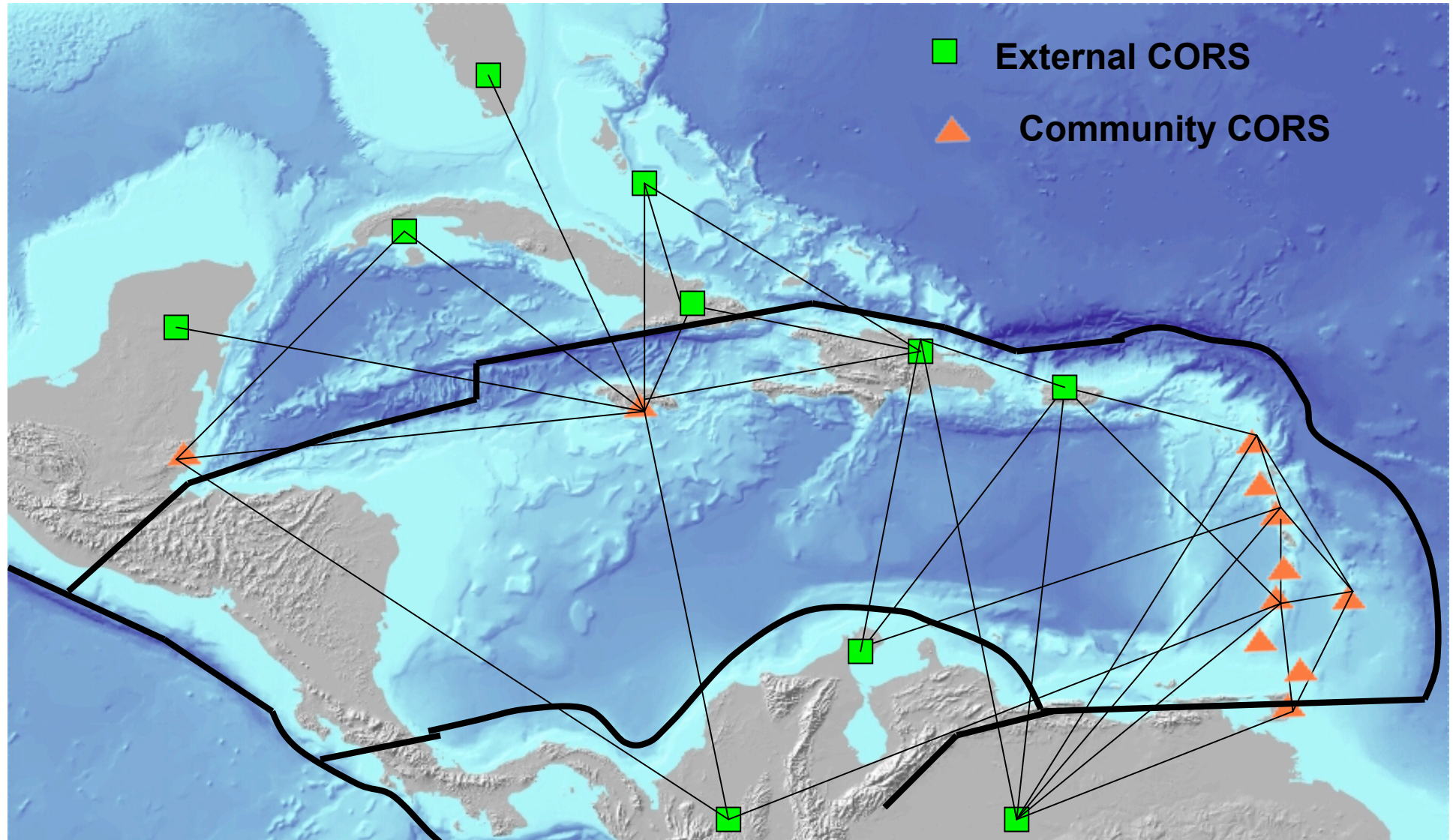
Global Challenges in Loss Estimation
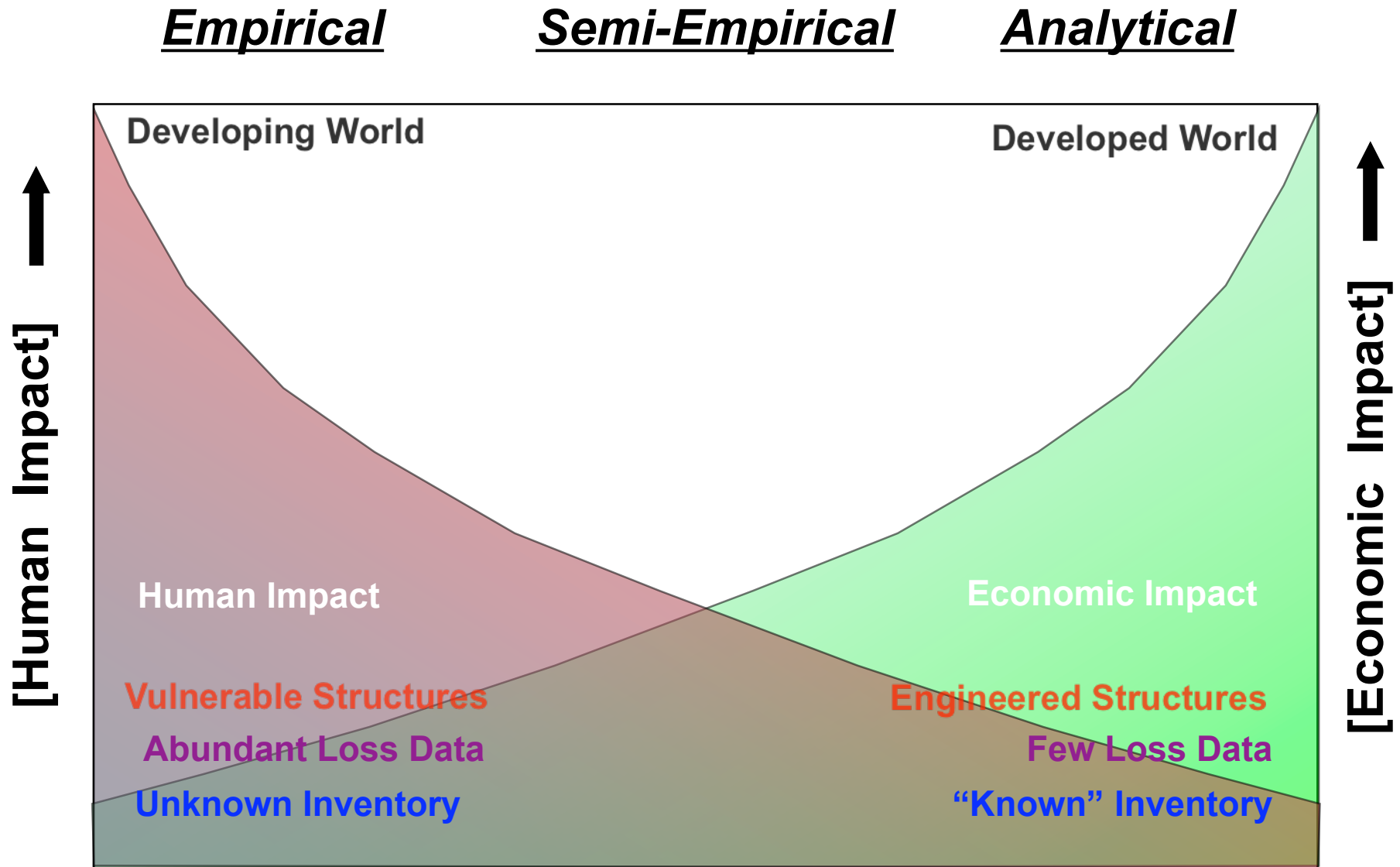
GEM architecture

Public Domain Area – Citizen-accessible Science

EARTHQUAKE HAZARD

1. Earthquake rates & distribution

2. Earthquake hazard (shaking)

EARTHQUAKE RISK

3. Building vulnerabilities

4. Building inventories

ECONOMIC RISK & DECISIONS

5. economic risk assessment

6. financial decision tools

Earthquake risk - Detailed scenarios
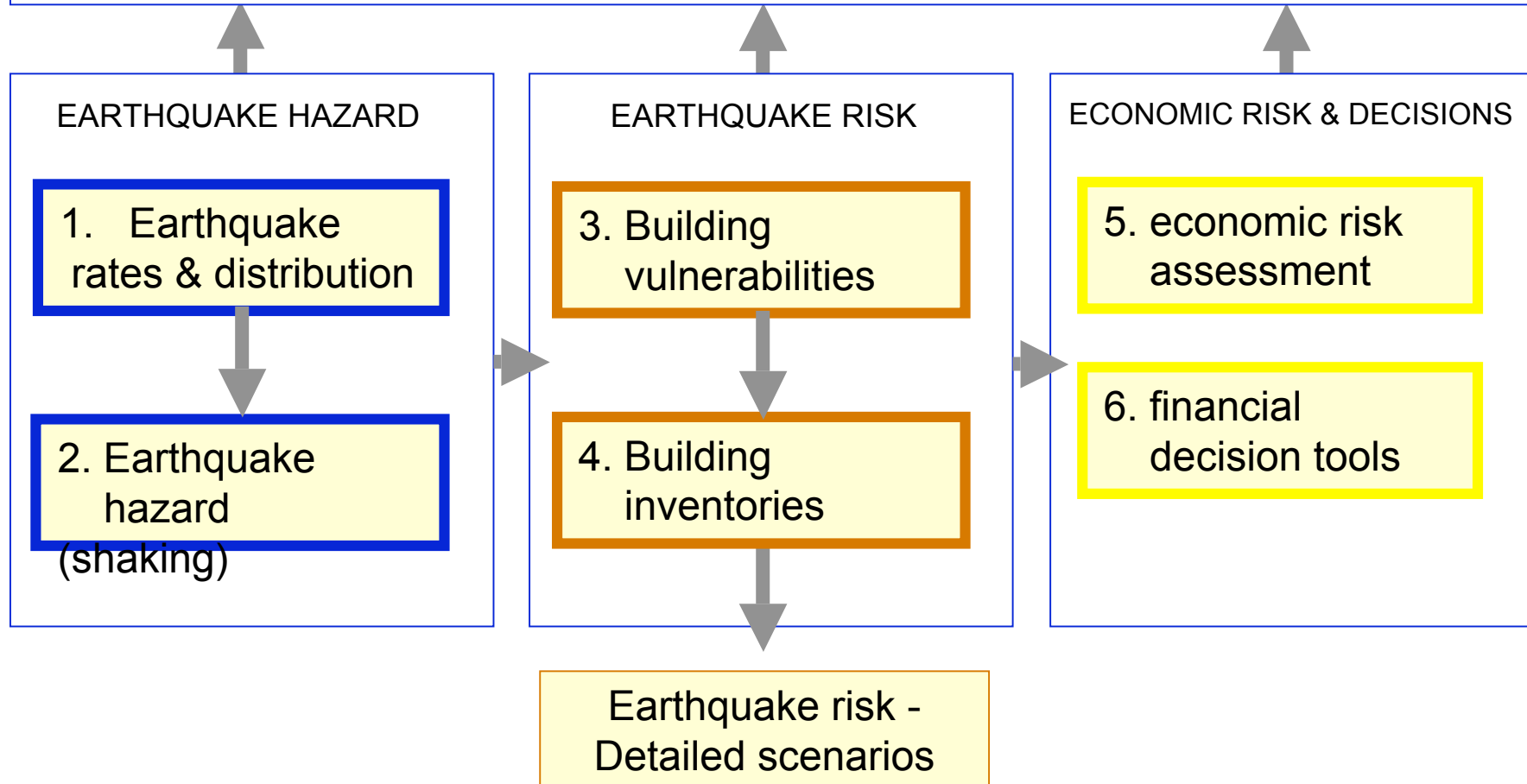
GEM Hazard Module

Two Sub-Modules:

1. **Activity Rates –** probability of occurrence of earthquakes in time and space
2. **Earthquake Hazard -** probability of exceeding a specific ground motion

Target outcomes of the hazard module include:

- Input data and databases at national, regional and global scales
- Global inventory of active faults (geometry, slip direction and rate)
- Global inventory of historical earthquakes
- Global set of regional harmonized strong-ground attenuation models
- Regional and global earthquake synthetic catalogue
- A global testing environment for use in future validation of new models/tools
- Hazard de-aggregation and sensitivity analyses
- Global/regional mapping of soil classif. for site-specific hazard assessment
- Regional & global hazard maps Spectral Hazard @1.0 and 0.2 s) and PGA

GEM Risk Module

Two two sub-modules: deterministic and probabilistic earthquake risk.

- Will introduce four types of risk indicators:

    1. Exposure of infrastructure and population

        Superposition of hazard maps on population, residential buildings, critical infrastructure and lifelines

    2. Damage to residential buildings

        Based on calibrated vulnerability fns. And ground shaking parameters

    3. Number of fatalities

        Will account for night-time and daytime distribution of population

    4. Complex indicators

        Social and economic indicators that combine various direct, indirect, and potential secondary effects of damage.

Risk Module: Targeted Outcome

- Harmonized vulnerability functions
- Regionalized, aggregated inventories
- Risk indicators for cities or countries
- Scenario risk assessments
- Overlays of probabilistic risk assessments with risk indicators
  - Population
  - Infrastructure (Inventory)
  - Residential building
  - Fatalities
  - Other (GDP, population growth, etc.)
- Development and dissemination of remote-sensing vulnerability methods
- Improved calibrations and tools for rapid loss assessment

Socio-Economics Module

Aims at providing knowledge and developing tools to calculate monetary loss information and deliver economic loss assessment at the aggregate level. It will build on existing open-source loss estimate initiatives.

Applications for Risk Management / Risk Communication:
- Losses fromx scenario: Deterministic & Probabilistic
- Applications to support specific decisions
  - Cost-benefit tools for risk reduction
    - Calculate only changes in loss & economic effects
    - User to calculate "denominator," e.g. development benefits or enforcement costs
  - Structures for Risk Sharing (including risk financing)
  - Users = Risk managers
- Indicators
  - Meaningful to ministries of finance & development agencies
  - e.g. Country's AAL / GDP (disaster resilience index)
  - Process-based rather than outcome-based:

Socio-Economics Module: Target outcomes

- Produce loss exceedance curves, including direct losses and confidence intervals, for varying regions

- Create an interface understandable to all risk owners

- Integrate existing open-source loss estimation tools

- Produce sample seismic loss scenarios at region-wide and nation-wide levels

GEM Implementation

- GEM will be implemented by sub-regions through established regional centers where capacity will be built up to maintain live models and databases
- Projected Key Risk Milestones include
- Year 1
  - Repository of inventories, fragilities, consequences
  - Inventory of software for hazard and risk
  - Identify regional leads
  - Sample risk computations for 3 cities
- Year 4
  - Complete GEM intellectual capacity building
- Year 5
  - Global, scalable, open-source framework
  - Consistent time-based risk estimates

Prospects for GEM Initiatives in the Caribbean

- SRC is already partnering with the Regional Centre for Seismology for South America, CERESIS (Trinidad and Tobago is a member state of the organization) to undertake GEM Initiatives in South America, more specifically CERESIS countries.

- We are also actively pursuing the remainder of the Caribbean community to develop a Caribbean Specific proposal to implement GEM in our region

- Efforts are also being made to target funds that have been set aside to develop hazard maps for CROSQ as well as to develop the earthquake risk component of a multi-hazard risk atlas project being negotiated by the Centre for Disaster Studies.

- www.globalearthquakemodel.org

Thanks for your attention…

Q & A